CLIMATE CHANGE AND MOUNTAIN PASTORALISM – THE SHAHSEVAN OF NORTHWEST IRAN

Asghar Tahmasebi, Eckart Ehlers and Conrad Schetter

With 4 figures and 7 tables
Received 17. September 2013 · Accepted 26. November 2013

Summary: High-mountain areas in arid environments are extremely sensitive indicators of sometimes only slight changes of precipitations and temperatures. This holds true especially for the so far under-researched mountain regions of Iran and its immediate neighbours. Climate change, however, is not the only consequence. Climate and environmental changes have deep impacts on the traditionally nomadic population, their economy and lifestyle. Thus, it is justified to speak of both ecological and socio-economic vulnerabilities that characterize the present-day development of Iran's mountain regions. Regional focus of this study is the Sabalan Kuh (4811 m) mountain area in northwestern Iran and its forelands. The paper tries to combine meteorological measurement over a 40-year time span with in-depth analyses of nomadic perceptions, experiences and adaptations to the obvious trends of a rapidly changing natural environment. While temperature increases are statistically significant (tab. 3–6), the analysis of precipitation data is less predicative (Fig. 4). Altogether however, temperature and rainfall trends suggest an increasing exposure of the Shahsevan pastoral nomads to environmental stresses. Interestingly, our analysis of "objective" meteorological data shows a high degree of accordance with the empirically founded "subjective" experiences of the affected nomads. Thus, their adaptation strategies show a clear trend towards different forms of agro-pastoralism as a reaction to both climate change and changing political as well as socio-economic pressures. This paper therefore concludes that the combination of natural and social science research is not only possible, but indispensable in order to gain insights into the close interactions between nature and society. And it is mandatory in order to develop sustainable development strategies for regions and people under stress. This conclusion holds true especially for studies on local to regional scales!

Zusammenfassung: Hochgebirge in ariden Klimaten sind besonders sensible Indikatoren für manchmal nur geringfügige Veränderungen der Niederschlags- und Temperaturregimes ihrer Umgebung. Dies gilt in ganz besonderer Weise für die bisher nur wenig erforschten Hochgebirgsregionen von Iran und seiner unmittelbaren Nachbargebiete. Klimawandel jedoch ist nicht die einzige Konsequenz solcher Veränderungen. Klima- und Umweltveränderungen haben tiefe Auswirkungen auf die traditionelle nomadische Bevölkerung dieser Regionen, ihrer Wirtschaft und ihrer spezifischen Lebensformen. Es ist deshalb gerechtfertigt davon zu sprechen, dass sowohl ökologische als auch sozioökonomische Verletzungen die heutige Entwicklung der iranischen Hochgebirgsregionen kennzeichnen. Regionaler Schwerpunkt dieser Studie ist das Sabalan Kuh-Massiv (4811m) im Nordwesten Irans und seiner Vorländer. Der Aufsatz versucht, meteorologische Beobachtungen über eine 40-Jahresperiode mit sozioökonomisch ausgerichteter Feldforschung zu den nomadischen Erfahrungen, Wahrnehmungen und Anpassungsstrategien an diese Veränderungen zu verbinden. Während die Temperaturanstiege statistisch einwandfrei nachweisbar sind (Tab. 3–6), ist die Analyse der Niederschlagsdaten weniger aussagekräftig (Abb. 4). Insgesamt jedoch deuten Temperatur- und Niederschlagstrends auf eine zunehmende Beeinträchtigung der Shahsevan-Nomaden gegenüber Umweltbelastungen hin. Interessanterweise weist unsere Analyse der „objektiven" meteorologischen Daten und ihr Vergleich mit den Ergebnissen der auf Feldforschung basierenden „subjektiven" Erfahrungen der Nomaden ein hohes Maß an Übereinstimmung auf. Die Anpassungsstrategien der Nomaden zeigen einen eindeutigen Trend hin zu verschiedenen Formen des Agropastoralismus als Reaktion auf sowohl Klimawandel als auch Veränderungen der politischen und sozioökonomischen Rahmenbedingungen. Die Studie kommt deshalb zu dem Schluss, dass eine Kombination von naturwissenschaftlicher Analytik und sozialwissenschaftlicher Feldforschung nicht nur möglich, sondern unabdingbar ist, um relevante Einsichten in die engen Vernetzungen zwischen Natur und Gesellschaft zu erreichen. Nur so wird es möglich sein, nachhaltige alternative Entwicklungsmodelle für Regionen und Gesellschaften unter Stress zu erarbeiten. Eine solche Schlussfolgerung gilt insbesondere für Studien auf lokalen bis maximal regionalen Maßstabsebenen!

Keywords: Iran, climate change, environmental change, high-mountain areas, nomads, vulnerability, adaptation, transdisciplinarity

1 Introduction

Due to their natural exposure, mountain regions and their ecosystems are extremely sensitive indicators of climate change on a global scale: Minor changes in temperature, insolation or precipitation show a direct impact on the extension of glaciers and snow pack, on the number and size of avalanches and on ground vegetation. As such, mountain regions as early-warning indicators of climate change have received specific attention by scientists of different kind: Glaciologists, meteorologists, geologists and geomorphologists, botanists (for Iran see e.g., Hagedorn et al. 1975; Kuhle 1976; Preu 1984). One has to bear in mind, however, that mountain regions are also human habitats, and that climate change has a strong impact on human life. Agriculture and animal husbandry are long-standing forms of land use in mountain areas, which are increasingly coming under stress due to climate change and having to cope with vulnerabilities of different kinds.

The bulk of research on high mountain agriculture or pastoralism and their changes have had its focus on the deteriorating impacts of governmental policies and socio-economic interferences into the historically developed interactions between nature and local societies so far. In contrast to more traditional compilations and to more or less descriptive case studies in the past (see e.g., Allan et al. 1988; Messerli and Ives 1984, esp. chpt. 16–19; Borsdorf et al. 2010 and others), specific analyses are rare. This holds true especially for the mountain regions of the Near and Middle East. With the exception of the nowadays more historical surveys, edited by Troll (1972) and Rathjens et al. (1973), not too much has been published on the high mountain regions of Iran and Afghanistan and their development of climate and environmental changes. Instead, the focus has shifted regionally to High and Central Asia and, increasingly, also to the close interactions between nature and society (see e.g. Huber et al. 2013 with focus on Swiss experiences; Kreutzmann 2012a, Kreutzmann 2013a and 2013b, Kreutzmann and Schütte 2011, Montero et al. 2009 or Price et al. 2013). Nevertheless, it is justified to argue that even today, most of the relevant academic literature focuses on the socio-economic and political dimensions and neglects the impacts of rapidly increasing climate and environmental changes. However, we argue in this article that high mountain agriculture and pastoralism are subject to both natural and socio-economic changes nowadays. Both strands of change can hardly be viewed separately and their mutual repercussions have to be taken into consideration.

Departing from this holistic understanding, the aim of this article is to investigate how research on ecological change, particular climate change, impacts social and economic changes of mountain nomadism – and vice versa. We argue that often enough and without reason natural sciences and social sciences hesitate to combine their data or to discuss to what extent their results strengthen or contradict each other. Against this background this article aims to show how results generated by statistic analyses of meteorological data can be combined with data generated by anthropological field research in pursuit of an integrated interpretation of causes and consequences of change among pastoral nomads in the mountain regions of Iran. With this approach we intend to show how the often lamented gap between natural and social sciences can be bridged. In our view, climate change can be understood as a scientific 'boundary concept' by combining the experiences and perceptions of the involved people with data collected by natural sciences methods.[1)]

In the following case study we will focus on climate and environmental change in the Sabalan Kuh (4,811m) mountain region in Northwest Iran (Fig. 1) and their impacts on the Shahsevan nomads. We aim to detect to what extent climate change in the particular area can be observed over the last four to five decades, analysing climate data from the Iranian Meteorological Organization. In a second step, this paper tries to combine these findings with the results of intensive field research based on an oral history approach, by interviewing pastoral nomads of the Shahsevan tribe about the changes of their natural habitat, their perceptions of these changes and their adaptation strategies.[2)]

Double exposure of pastoral nomadism

The starting point of our analysis is that pastoral nomadism has to be seen as a highly vulnerable

[1)] For one of the first attempts to define a cross-disciplinary boundary concept see Star and Griesemer (1989). They define it as follows: "Boundary objects are objects which are both plastic enough to adapt to local (or disciplinary) needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites …" (1989, 393). For our purpose: Mollinga (2010).

[2)] For a detailed analysis of these interactions see Tahmasebi (2013). The title of the original study was "Pastoralism under pressure: vulnerability of pastoral nomads to multiple socio-political and climate stresses. The Shahsevan of North Iran".

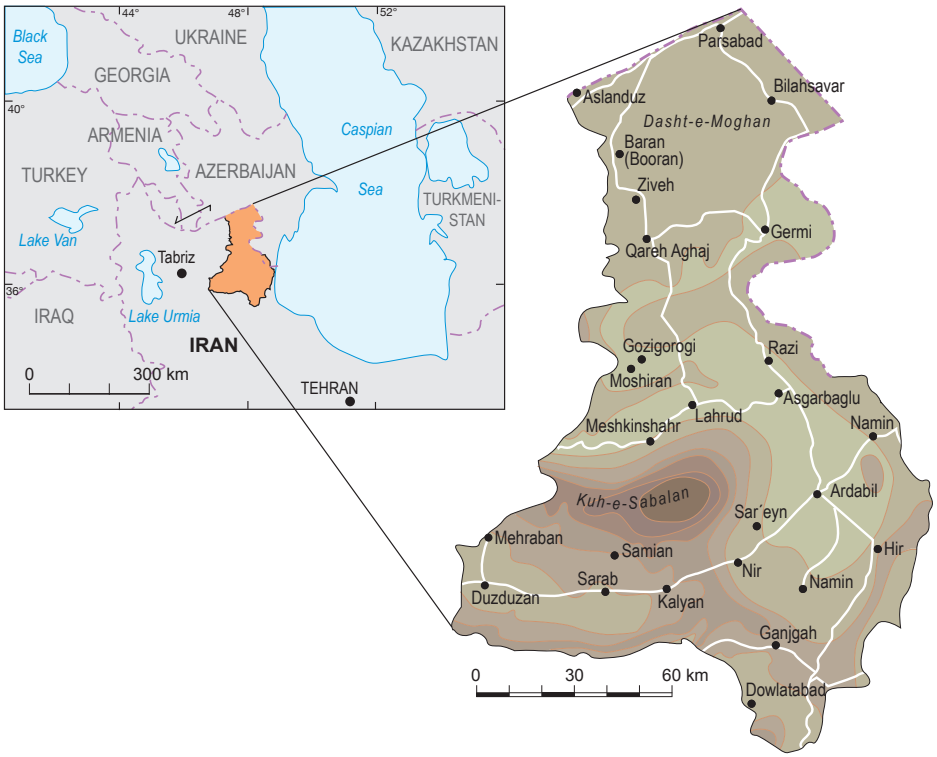

Fig. 1: The study location: the territory of the Shahsevan pastoral nomads in Northwest Iran

form of livelihood in today's world. Pastoral nomadism – particular in the ancient dry belt – is a livelihood strategy that makes use of ecological niches that can hardly be used for permanent agriculture or other forms of agro-pastoralism. Particular ecological zones, such as high mountains, steppes, savannas or deserts, which can be used for livestock breeding for an annual short period of time of two to four months, became the basis for pastoral nomadism. The combination of such ecological niches by regular migrational patterns characterizes pastoral nomadism, demonstrated over the past millennia by a high grade of adaptation to changing environmental as well as socioeconomic and political conditions ("classical" surveys are those of JOHNSON 1969 or SCHOLZ 1995; 2008). However, since the 20th century, nomadism got under enormous stress to such an extent that some researchers argue that nomadism in its traditional form is "dead" and is to be replaced by forms of "mobile animal husbandry" (SCHOLZ 1999). The establishment of nation states, the increasing impermeability of their borders, the quests for internal stability and control or the modernization of national economies, especially of their agricultural sectors: All this caused stress and pressures on nomadic societies and economies (for Iran see e.g., ANSARI-RENANI et al. 2013; BECK 1991; BLACK and MICHAUD 1986; EHLERS and SCHETTER 2001; GARTHWAITE 1983; OBERLING 1974). While political and socio-economic factors have dominated the current discussion so far, changes of the ecological environment as stress factors have been added only recently as causes of nomadism under pressure.

The Azari-speaking Shahsevan in Northwestern Iran are an interesting and well-documented case (TAPPER 1979; 1997; 2002; SCHWEIZER 1970; 1973) for studying social change and adaptation of pastoral nomadism in Iran. The Shahsevan are the third largest pastoral group in Iran in size of human population and animal husbandry after the Bakhtiari and Qashqai tribes (see Tab. 1). Their summer pastures are located in the highlands of the Sabalan Kuh mountains with heights up to 4811 meters, while their winter grazing areas are located in the surrounding lowlands of the mountain, especially in the Dasht-e Moghan in Ardabil province (see Fig. 1 and 3). The Shahsevans' adaptations to the pressures and the influence of the Iranian nation-state, as well as the impacts of modernization have been thoroughly discussed by TAPPER (see above). The exposure of the Shahsevan nomads towards ecological changes, however, was hardly taken into consideration of re-

Tab. 1: Population and animal husbandry of major tribal confederations in Iran in 2008 (ISC 2012)

Confederation of tribes	Tribe	Household	Population	Animal number(sheep, lamb, goat and kid)	Geographical location (Main province)
Bakhtiari	59	23,094	140,342	1,658,025	Khuzestan, Fars, Esfahan
Ghashghaii	6	17,971	96,339	1,967,988	Fars, Bushehr, Khuzestan
Shahsevan	42	12,985	67,093	1,329,639	Ardabil
Khamse	4	7,461	38,036	973,872	Fars
Gharehdagh-Arasbaran	6	6,852	36,682	631,269	East Azerbaijan
Miond	6	4,186	24,291	347,654	Lorestan, Khuzestan
Boyerahmas-sofla	33	3,843	23,653	272,908	Kohgiluyeh and Boyer-Ahmad
Gholkhani	20	3,953	23,235	307,375	Kermanshah
Harki	4	2,447	17,318	211,894	West Azerbaijan
Jalili	10	2,736	15,789	324,923	West Azerbaijan
Bahmaii	31	2,465	15,782	181,305	Khuzestan, Kohgiluyeh and Boyer-Ahmad
Mamasani	4	2,478	15,377	175,449	Fars,Kohgiluyeh and Boyer-Ahmad
Milan	9	2,596	14,995	291,099	West Azerbaijan
Balooch	21	2,975	14,670	240,837	Kerman,Baluchistan
Kalhor	6	2,579	14,613	295,999	Kermanshah
Kord	37	2,186	13,829	282,994	Ilam
Boyerahmas-olya	21	1,872	11,994	163,386	Fars,Kohgiluyeh and Boyer-Ahmad
Zelki	23	1,918	10,667	110,947	Khuzestan,lorestan
Tibi	17	1,524	9,903	95,836	Khuzestan, Kohgiluyeh and Boyer-Ahmad
Afshar	23	1,330	6,675	132,554	Kerman
Total	**382**	**107,451**	**611,283**	**9,995,953**	

search so far. In this context it should be noted that nomadism in Iran is by no means dead (Tab. 1), although it is true that it is a lifestyle under extreme pressures with deteriorating effects not only on the Shahsevan but also on all other tribes in Iran – and beyond!

As mentioned before, pastoral nomadism is caught in an intricate system of vulnerabilities. For the purpose of our study and its focus on climate change consequences, it is sufficient to follow IPCC's very general definition of vulnerability as "the propensity or predisposition to be adversely affected" (IPCC 2012, 3). Without going into a detailed methodological discussion[3] (Birkmann 2006), we refer to Bohle's comprehensive approach in which the concept of vulnerability is laid out. According to him, vulnerability consists of both externalities and internalities that constitute individual or societal vulnerabilities (Bohle 2001; 2007; Brklacich and Bohle 2006). Its external factors are those of human exposures to changes or stressors, be they of social, political, economic or environmental nature. The internal side of vulnerability refers to the inability of individuals or communities to cope with them. Both internal and external stressors are divided into a wide range of causes and consequences, partly interwoven and interconnected (see also Brooks 2003; Ford and Smit 2004 or Turner et al. 2003). The ability and capacity to cope with or adapt to them depends on a broad range of factors. The severity of the stressors is one side of the coin. Social coherence, political

[3] For a comprehensive and rather up to date survey see the collection of articles by Birkmann (2006).

strength and/or a strong economic basis is the other side. Both determine the societies' resilience to resist, absorb or accommodate to these stressors.[4)]

As shown in figure 2, we conceptualized pastoral vulnerability as a function of "double exposure" to socio-political and climate stresses at the external exposure level. The adaptive capacity and the sensitivity of their pastoral life and production system serve as internal determinants. The sensitivity and adaptive capacities determine also the Shahsevans' strategies to cope with these combined pressures on their traditional lifestyle and their livelihoods. However, the coping and adaptation strategies adopted by nomads influence, vice versa, their sensitivity, adaptive capacity and exposure to future socio-political and climate stresses. It is this double exposure, i.e., the exposure to socio-political as well as to increasingly strong environmental and ecological constraints, that we identify as the key challenge with which nomadism and agropastoralism have to cope – not only in Northwestern Iran, but in almost all high altitude environments in West and Central Asia (e.g., Kreutzmann 2012a and 2012b; Kreutzmann 2013b; Kreutzmann and Schütte 2011; Schütte 2012; Schütte 2013).

It goes without saying that the combination of extremely harsh ecological environments and the fragilities of a highly traditional economy under stress pose extreme challenges to those internal sides of nomadic vulnerabilities. As much as coping and adaptation strategies have accompanied nomadic life and economy over centuries and have been part of their survival (for a comprehensive evaluation Scholz 1995; 2008), their coping and adaptation strategies had to go far beyond those of peasants or urbanites. Thus, mountain nomadism as well as montane agropastoralism are much more than purely rural or urban lifestyles subject to ecological, socio-economic or political stressors. They are therefore also much more vulnerable and appropriate indicators of change and its challenges.

2 Climate change in the mountain regions of Northwest Iran

Having indicated our understanding of vulnerability, the complexity of research in this field becomes obvious. Instead of dealing with the whole range of both ecological and socio-political impacts on nomadic societies, this article will concentrate first and foremost on the exposure of nomads to climate change. This aspect is of particular interest for two reasons: It is located at the interface of findings of natural and social sciences research. Moreover, the scientific state of the art shows that particularly integrative analyses are not available for many parts of mountain regions in the world. While the Himalayan mountain ranges, the Andes, the Alps and the Rocky Mountains are partly covered by micro analyses, the afore-mentioned Middle East, especially Iran, is among those regions that have hardly been analysed in detail, especially not in regard to the consequences of climate change. This is why analyses such as the IPCC reports, which aim to formulate global trends and prognoses, are mainly based on observations in regions that have been well equipped with meteorological stations for decades. Trends in less well-covered areas are less reliable and incomplete, although they may be the most affected regions of changes.

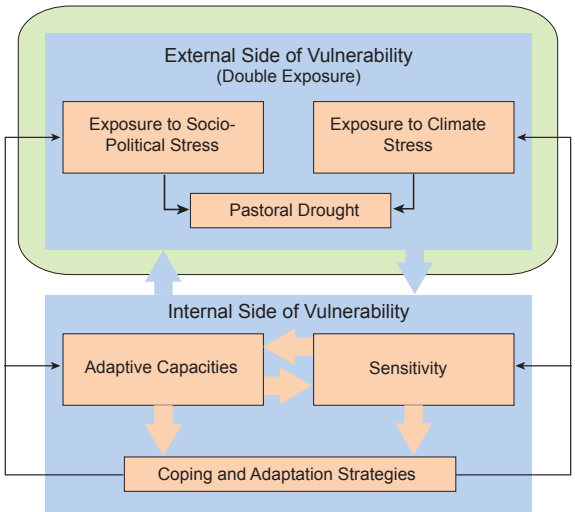

Fig. 2: Conceptual framework for pastoral vulnerability: double exposure to socio-political and climate stresses

The Fourth Assessment Report of IPCC states that many regions of Asia are experiencing a significant increase in magnitude, frequency and duration of climate extremes: "[…] significantly longer heat wave duration has been observed in many countries of Asia, as indicated by pronounced warming trends and several cases of severe heat waves. […] increasing frequency and intensity of droughts in many parts of Asia are attributed largely to a rise in temperature, particularly during the summer and normally drier months" (Cruz et al. 2007, 473). The report further highlights some observed impacts of climate change on rangelands ecosystems and their production as

[4)] For the purpose of clarity, we refer to the definitions suggested by the International Strategy for Disaster Reduction: UNISDR Terminology on Disaster Risk Reduction (UNISDR 2009).

the main livelihood source for pastoral nomadism: "[…] with the gradual reduction in rainfall during the growing season for grass, aridity in Central and West Asia has increased in recent years, reducing growth of grasslands and increasing bareness of the ground surface" (Cruz et al. 2007, 478). IPCC's hints to the impacts of precipitation change on the productivity of grassland are an indication for nomadic vulnerabilities, since nomadism and pastoralism are dependent on the availability of grass, both in their high mountain summer pastures (*yaylaq*) and in the wintry mountain forelands (*qeshlaq*). Variations in temperature and precipitation, therefore, have always been challenges to the nomadic way of life. Long-term changes, however, are critical for its survival. It is against these backgrounds that our own study puts special emphasis on a clearly defined region and an in-depth analysis of its observed temperature and precipitation data over a 35 to 45-year period. And also our conclusions as well as the perceptions of the affected people will go beyond those afore-mentioned general findings of the IPCC report of 2007 (Cruz et al. 2007).

Climate data analysis

Evaluation of the possible impact of long-term climate variation on characteristics of climate-related stresses and its implication for Shahsevan pastoral life require a detailed analysis of long-term trends in climate data. This analysis is based on an earlier study by Schweizer (1970). His detailed analysis of the climatic situation of the Sabalan Kuh area provides a general impression of the harsh environmental conditions for nomadism and nomads. According to Schweizer (1970, 87–89), the highlands of the Sabalan Kuh area are characterized by a continental climate with annual variations of temperatures of up to 25 °C between the coldest and warmest monthly average (Fig. 3). Temperature extremes ranged from -25 °C and +40 °C. Precipitation, too, shows a wide range. While the Caspian lowlands (Astara) are dominated by moist Caspian air masses and humidity all-year round (Astara: >1200 mm), highland stations like Ardabil (386 mm), Sarab (286 mm), Ahar (354 mm) or Moshiran (156 mm) receive distinctly less rain and snow, resulting in lengthy arid seasons during the summer months.

On the basis of these valuable data, we have updated Schweizer's analysis with new and more recent observations and have put special emphasis on the phenomena of potential climate changes. The precipitation data of seven stations and temperature series from four stations, with 35–45 years of data (Tab. 2), were obtained from the Iranian Meteorological Organization and Ardabil Water Resource Institute. Considering the impact of seasonality and short-term variation of climate factors on the Shahsevan pastoral life, the monthly precipitation data and temperature series, i.e. the monthly means, maximum, minimum, absolute maximum and absolute minimum temperature were used for this analysis (see also Fig. 3).

Generally, two categories of parametric and non-parametric tests are used for trend detection in climate series. Non-parametric statistics are mostly robust and useful when the distribution of data is unknown or not normal (Rodrigo et al. 1999). Among non-parametric methods, the Mann-Kendall test is

Tab. 2: The characteristics of meteorological stations in the Sabalan Kuh area

No	Station	Longitude	Latitude	Height in m	Data Period		Number of Years
					Precipitation	Temperature	
1	Aslanduz	39-25-56	47-22-26	161	1967-2006	1966-2006	40 Rainfall, 41 Temp
2	Borran	39-19-08	47-31-07	250	1969-2006		38 Rainfall
3	Moshiran	38-32-55	47-32-06	680	1966-2005		40 Rainfall
4	Nir	38-02-22	48-01-07	1593	1966-2005		45 Rainfall
5	Namin	38-24-51	48-28-03	1405	1961-2005	1966-2006	45 Rainfall, 41 Temp
6	Samian	38-22-29	48-14-47	1286	1971-2005	1971-2005	36 Rainfall , 36Temp
7	Sarab	38-02-16	47-40-39	1682	1972-2006	1972-2006	35 Rainfall, 35 Temp

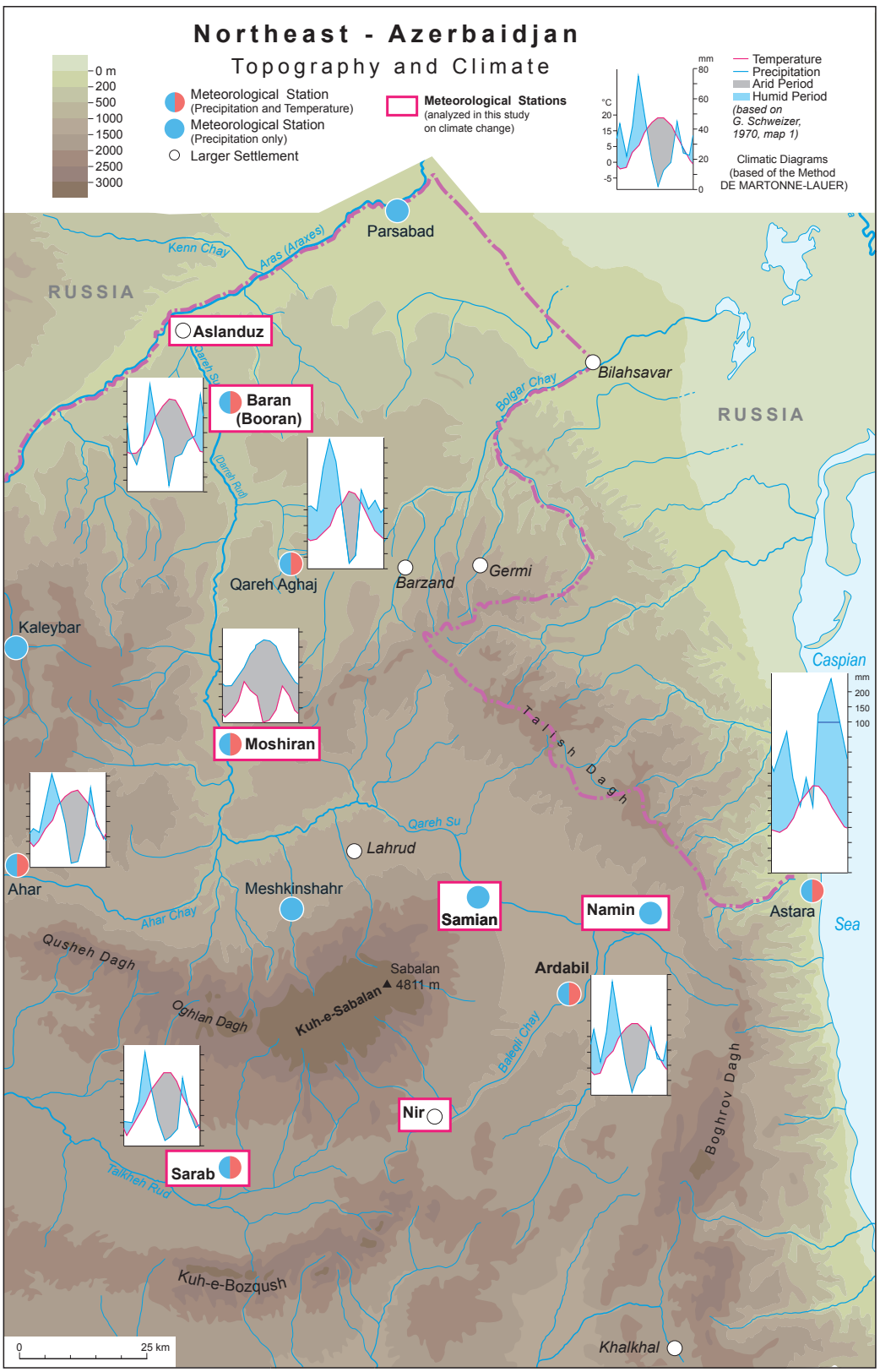

Fig. 3: Northeast Azerbaijan: topography and climate (based on SCHWEIZER 1970, map 1) and location of the meteorological stations analyzed in this study

widely used for analyzing the monotonic (single-direction) trend in climate data. Particularly important about this method is the fact that it allows for missing data and its results are not affected by outliers. However, the existence of serial correlation in the data series could significantly influence its results. Therefore, first, the Thom test (IRICS 2011; TECER and CERIT 2009) was applied to examine the homogeneity of data, and the results confirmed the homogeneity of all series at a 95% confidence level. In a second step the data were examined for existence of serial correlation by computing the lag autocorrelation of *"r"* at Lag-1. The pre-whitening process suggested by STORCH (1999) was applied to the data with a significant correlation coefficient at 5% level (series highlighted in grey color in tables 2 to 5). The original data of X_t, therefore, were replaced by $Y_t = X_t - rX_{t-1}$ and the process continued until the autocorrelation decreased under 5% level significance. The Mann-Kendall test, then, was applied to evaluate the existence of significant trend in precipitation and temperatures series. Being a nonparametric test, the Mann-Kendall method assumes no specific distribution for the data and uses the comparative magnitude of series than the original data (HIRSCH and SLACK 1984).

Therefore, first the Mann-Kendall statistic of S, also known as Kendall's τ, is computed using equation (1) by comparing each data value of X_k with all its subsequent values of X_j and applying the signum function (2) to the results.

$$S = \sum_{k=1}^{n-1} \sum_{i=k+1}^{n} sgn(X_j - X_k) \quad (1)$$

$$sgn(x) = \begin{cases} +1 \text{ if } (X_j - X_k) > 0 \\ 0 \text{ if } (X_j - X_k) = 0 \\ -1 \text{ if } (X_j - X_k) < 0 \end{cases} \quad (2)$$

Accordingly, each pair of comparisons was assigned a number: +1 when the latter value was larger than X_K, -1 when it was smaller, and 0 where it was equal to X_K, and the statistic of S was calculated by summation of all these number. Then the variance of S and statistic of Z were computed using the equations (3) and (4) respectively.

$$\text{Var(S)} = \frac{n(n-1)(2n+5) - \sum_{j=1}^{m} t(t-1)(2t+5)}{18} \quad (3)$$

$$Z = \begin{cases} \frac{S-1}{\sqrt{Var(S)}} & \text{if } S > 0 \\ \frac{S+1}{\sqrt{Var(S)}} & \text{if } S < 0 \end{cases} \quad (4)$$

The data series will show the significant trend, typically at a 95% or 99% level, if the absolute value of calculated Z is higher than its respective value in an acceptable level of significance. The positive and negative value of Z will further indicate its upward or downward trends respectively.

The results of the Mann-Kendall test showed a considerable trend in temperature parameters in comparison with rainfall data. Among the seven stations with precipitation data, statistically significant ($P<0.05$ and $P<0.01$) trends were found only in two stations, namely Nir and Samian. Both stations showed a declining trend in the March monthly rainfall at a 5% level of significance. The precipitation in Nir, furthermore, showed significant declining trends in April and an increasing trend in July at a 1% level. There were no major trends observable in the monthly rainfall of other stations. This result is consistent with the findings of MODARRES and VICENTE (2007) in a study on the trend of monthly rainfall in the arid and semi-arid regions of Iran. They found statistically significant trends in a few stations, e.g., Anarak, Isfahan, Sabzevar, mainly in March and April. However, their study indicates major increasing trends in March and decreasing trends in April, while in the current research both April and March rainfall had negative trends. In another study, RAZIEI (2008) examined the long-term trend of precipitation in five homogenous subunits of western Iran and found statistically significant negative trends in the northern part in Azerbaijan region, in the west of our study area, and insignificant positive trends in Iran's southern part, specifically in the Hormozgan region.

Tables 3 to 6 present the results of our trend analysis on monthly temperature data in the Shahsevan territory. As can be seen from table 3, the monthly mean temperature in all four stations had a generally increasing trend, particularly between June and October. The most significant rising shift was found in August and September. Among these stations, Aslanduz is located in the Shahsevan winter pasture, and the other three have more proximity to their summer pasture. In other words, the data suggest a more significant ($P< 0.01$) upward trend of temperature series in summer pasture (*yaylaq*) compared to their winter pastures (*qeshlaq*) in Moghan with a generally increasing trend of a 5% level of significance.

As documented in table 4, furthermore, the monthly maximum temperatures have shown statistically significant increasing trends in almost all stations throughout the year. Without going into details of a closer analysis of the absolute temperature (and

Tab. 3: Long-term trends in monthly mean temperature in the Shahsevan territory

Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Aslandoz			● ↑	● ↑	● ↑	● ↑	● ↑	● ↑			● ↑	
Namin	● ↑		● ↑	● ↑	●● ↑	●● ↑	● ↑			● ↑	● ↑	
Samian				● ↑	●● ↑	■ ● ↑						
Sarab		● ↑	● ↑		● ↑	●● ↑	●● ↑					

Tab. 4: Long-term trends in monthly maximum temperature in the Shahsevan territory

Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Aslandoz			● ↑		● ↑		● ↑				● ↑	●● ↑
Namin	● ↑	● ↑	●● ↑		●● ↑	■ ● ↑				● ↑	● ↑	● ↑
Samian												
Sarab		●● ↑	● ↑			● ↑	● ↑					● ↑

Tab. 5: Long-term trends in monthly minimum temperature in the Shahsevan territory

Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Aslandoz				● ↑		■		● ↑			● ↑	● ↑
Namin					● ↑	●● ↑					●● ↑	
Samian				● ↑	●● ↑	■ ● ↑	■				● ↑	●● ↑
Sarab						●● ↑	●● ↑					

Tab. 6: Long-term trends in absolute monthly maximum temperature in the Shahsevan territory

Station	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Aslandoz			■				● ↑	● ↑				
Namin	● ↑	● ↑	● ↑			●● ↑	● ↑	● ↑		■	● ↑	● ↑
Samian		● ↑		● ↓		● ↑				● ↑		● ↑
Sarab				● ↓								

● if trend at α = 0.05 level of significance
●● if trend at α = 0.01 level of significance
↑ Increasing trend
↓ Decreasing trend
■ Significant serial correlation at 5 % level

precipitation) data of our research area[5], the general trend is clear. While monthly mean as well as monthly maximum temperatures show generally increasing trends, the deviations of these trends on local scales are by no means unusual and coincide with the above mentioned observations in other parts of Iran.

Concerning the trends of the monthly minimum temperatures (Tab. 5), they show a distinctly more significant upward trend in the stations located in the highlands, particularly in February and March. This process may contribute in receiving less snow in the highlands of Sabalan Kuh while the general increasing temperatures could influence earlier melting of the snow pack as observed by the Shahsevan. The absolute monthly maximum temperature is another indicator for heat stress. As shown in table 6, it had the only negative trend in July in Samian and Sarab stations while it has increasing trends in all other stations in almost all seasons. Besides the fact that seemingly inconsistent trends are in line with similar observations in other parts of the country, the overall picture of northwestern Iran's temperature trends supports the nomads' experience and perceptions of obvious climate changes and their impacts on nomadic animal husbandry (Chpt. 3).

[5] A detailed analysis and publication of temperature and precipitation trends for northwestern Iran is in preparation.

While the closer analysis of the temperature regimes in the Shahsevan territory identifies clear trends as expressed in tables 3 to 6, precipitation data are less predicative. In absence of a detailed analysis of precipitation data and their long-term trends, it must suffice to point to pastoral drought perceptions by the Shahsevan nomads. Drought is one of the main threats to all those forms of animal husbandry and especially to those regions where pastoral nomadism is prevalent. In general terms, it is a period of shortage of available water due to a deficiency of precipitation. It is mostly classified into four drought types, namely meteorological, hydrological, agricultural and socio-economic. Several drought indices such as Percent of Normal, the Palmer Drought Severity Index (PDSI) or the Standard Precipitation Index (SPI) have been developed for monitoring those types of drought[6] that are endangering rangeland in arid and semi-arid environments. Figure 4 reconstructs the winter pasture (*qeshlaq*) situation of Aslanduz (161 m a.m.s.l.) for a 40-year-period and the 30-year-*yaylaq* situation in Ardabil (1350 m a.m.s.l.). The comparison shows that the Shahsevan have been exposed to a number of severe summer droughts over the last 33 years. Comparing the data for Aslanduz station with those of Ardabil shows some similarities in the occurrence of drought periods in summer (*yaylaq*) and winter (*qeshlaq*) pastures. The 2009 winter drought in Ardabil for instance was most likely the continuation of the 2008 drought in the summer rangelands. However, in some years (e.g. 1996–1998) the summer pastures experienced moderate to severe wet conditions, while the winter pastures faced a moderate drought (for a closer analysis see Tahmasebi 2013, 73–82): Another indication of those often observed changes in climate variability in time and space.

Temperature and rainfall trends in the study area suggest an increasing exposure of the Shahsevan pastoral nomads to climate stresses. This observation holds especially true for the thermal regime. The upward trend of temperature in winter time is likely to contribute to the change in precipitation regime and to the decrease of the amount of snowfall, particularly in the higher parts of Sabalan Kuh. The general rising temperature, on the other hand, could significantly reduce the amount of snow pack accumulation as a source of water for pasture and animals in *yaylaq*. Furthermore, the steadily declining trend of precipitation and increasing temperature leads to more evapotranspiration and, thus, water and vegetation shortage on the rangelands.

3 Climate change: its impact on and perception by the nomads

In order to evaluate the specific conditions of the Shahsevan territories in more detail, we included not only officially available meteorological data, but also integrated the nomads' perceptions and their experiences with the changing climatic and environmental conditions by using anthropological field research methods[7] Several focus group discussions and twenty in-depth interviews were conducted with nomad elders, mainly over 50 years old. Their oral history on changing climate condition over the last decades and its impacts on their pastoral life is not only based on own observations and experiences, but also shows a high degree of correspondence with the official data of the long-term measurements of the Iranian Meteorological Organization. The majority of the nomadic respondents perceived that their environment is 'getting warmer and drier', and thus the conditions of their ecosystems are changing. This, however, has severe consequences on the traditional lifestyle of the nomads – and especially on the seasonal patterns of their annual migration cycles. Increase in temperature and decrease of precipitation, for instance, cause severe changes in the growing season of the vegetation in their summer rangelands. And they are very well perceived by the nomads. These changes are reflected in the observations and experiences of the nomads, although sometime in an indirect way. For example, Jamshid from the Haji-Khwajalu tribe shared his observation about changing climate conditions in the region and said: "[…] the weather has changed and become warmer. Now the forage of our winter pasture in Moghan dries much earlier. Even 45 days after Nowruz (Persian New Year) we have to supplement our animal with barley. […] the rainfall has become much scarce. Particularly, in the winter time which is critical for having good pasture in early spring in Moghan" (Personal communication, 10 May 2009.

Alhahshukur from the Khalaflu tribe believes that much of the change in the climate conditions can be seen in summer pastures (*yaylaq*). He explained the influence of global warming on their *yaylaq* around Sabalan Kuh in the following way: "[…] I have been grazing our herd in these pastures since

[6] For a closer analysis of the SPI and its calculation in the context of this study see Hayes 2002 (also Fig. 4).

[7] For further details see Tahmasebi (2013), esp. pp 85–130.

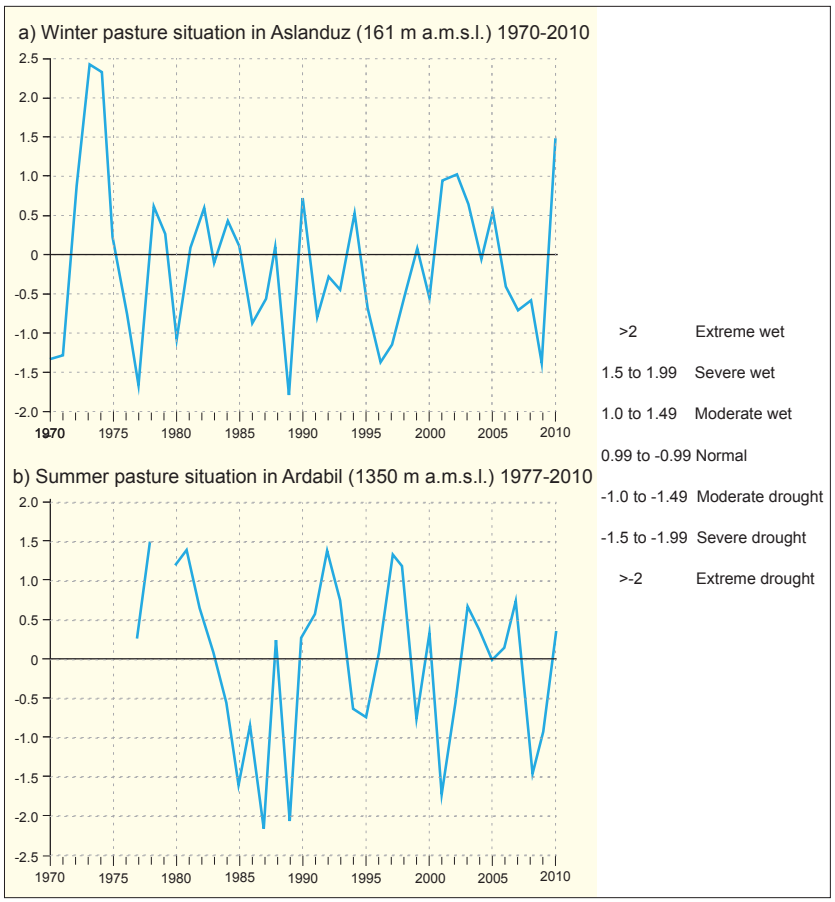

Fig. 4: Nature and intensity of meteorological droughts on Shahsevan winter and summer pastures, based on six-month Standard Precipitation Indices (SPI). a) Winter pasture situation in Aslanduz (161m a.m.s.l.) 1970-2010; b) Summer pasture situation in Ardabil (1350m a.m.s.l.) 1977-2010

I was a small child. We used to use our yaylaq pasture in the highland of Sabalan-kuh in early Tirmah (late June) because the land was mostly covered with snow, and it was almost impossible to pass through. The pasture was also immature by then. Now we are coming in early June and there is no more that much snow in the mountain, and the plants are grown well in June" (Personal communication, 25 June 2009).

These observations are in line with the comments raised by Haj Avaz from the Moghanlu tribe who thinks there has been a significant decline in the snow pack of Sabalan Kuh as the main source of water for their pasture and animals. He said: "[…] the snow in highlands of our summer rangelands in Sabalan Kuh used to last until the end of summer and be covered by new snow in early autumn while now it hardly lasts for midsummer every year" (Personal communication, 11 July 2009).

Some other nomads, however, believe that the weather condition is dependent on God's will. They believe that more drought and higher temperature conditions are caused by changes in people's beliefs and changing behaviours toward God. When asked about the observed change in climate conditions over the last decades Jebariel from the Gotlar tribe argued: "[…] everything is in his hand. He can send the rain, wind and the heat anywhere and anytime. […] the fact is that the people become bad. They easily lie and cheat on each other. Many people don't pay quint and Zakat. Of course, he will punish us with more drought and famine" (Personal communication, 14 May 2009).

Going beyond the experiences of knowledgeable individual nomads, a closer examination of the general livelihood strategies of the Shahsevan and their rapidly changing adjustments to both ecological and socio-economic stressors reveal a great flexibility of the nomads towards these challenges. This becomes apparent in two ways. First, nomadism sensu stricto has split up into different livelihood strategies. Based

on a total of 277 household interviews, Shahsevan nomadism has developed five strategies to cope with both climatic and socio-economic change. While the majority (approximately 33%) have entered into what is called pasture partnership (*koda gonshuluq)*, i.e., cooperation between two or three pastoral households in regard to herding practices and the joint uses of summer (and winter) pastures, other households follow either semi-nomadic (21%) or semi-sedentary (7%) animal husbandry with dominance of pastoralism in the first case and agriculture in the second. Shepherding (15%) resp. herdsmen husbandry (24%), i.e., the use of employed and wage-dependent herdsmen, are other forms of adaptation. These differentiations are clearly reflected in different access profiles of the Shahsevan according to their access to and availability of their capital equipment (for details of capital availabilities – natural, financial, social, human and/or physical capitals – see Tahmasebi 2013, 90–122).

The Shahsevan perceptions, therefore, fully support our meteorological analysis that their exposure to climate stresses, particularly drought and consequently forage shortage has increased. The high convergence of objectively measured meteorological data and subjectively felt consequences by the nomads thus is a plea for a stronger inclusion of local people's knowledge and experiences into both climate and environmental change discussions. Such a plea holds especially true for harsh and remote environments where meteorological data are scarce or totally missing. High mountain pasture lands in the Middle East and Central Asia are part of them. Their only seasonal use by nomads or agro-pastoralists as well as the nomads' adaptation to environmental change is usually based on traditional practices and is not liable to or dependent on scientific recommendations – another reason for the adequate observation of human responses to long-term climatic variations and their inclusion in the very often too superficial climate change discussions.

Climate changes, however, are not the only, maybe not even the decisive factor for today's problems of mountain nomadism. As suggested in our conceptual framework (see Fig. 2), pastoral drought also results from the impacts of socio-political changes. These influences are aggravated by the impacts of socio-political and economic pressures, i.e., the diminishing size of pastoral rangelands, the pressure of agriculture and rural animal population on rangelands and their integration into market economy. The collective impacts of increasing meteorological and socio-economic droughts, therefore, are among the main root causes of their increasing vulnerability.

4 Concluding remarks

Our analysis of "objective" meteorological data and their juxtaposition with the empirically founded "subjective" experiences of the nomads show a high degree of accordance. Admittedly, similar observations and experience with climate change and their impacts on grazing lands and migrational patterns have been reported by many nomads in Iran, although their causal connectivity with the objective impacts of climate change have never been analyzed before (see e.g., Ansari-Renani et al. 2013). This is the more remarkable since the number of tribal people and households in Iran is still significant, the number of animals and their contribution to the national economy of the country even more so (Tab. 7). Especially the number of sheep and goats cover more than a quarter respectively more than a third of Iran's total stock. Nomads thus contribute significantly to the country's overall milk, meat and wool production, thus representing a major economic factor. More than many words, these figures are testimony to the fact that nomadism in Iran – as elsewhere – fulfils important economic functions, notwithstanding the obvious signals of its decline and replacement by those afore-mentioned forms of mobile animal husbandry. It is against this background that Scholz's plea to (re-)consider the ecological and socio-economic role of nomads and nomadism very carefully (Scholz 1991) is indispensable even today.

Climate change research in the high mountain regions of Iran therefore is by no means an end it itself. On the contrary: The inclusion of traditional knowledge systems and the acknowledgement of indigenous sensitivity towards environmental changes are extremely important assets for future climate change research, especially in regions where meteorological observations are not available. Hermann Kreutzmann's (2012) collection on pastoral practices in High Asia shows to what extent negligence of

Tab. 7: Nomadic population and animal husbandry in comparison to the overall national figures in 2008 (ISC 2012)

	Nomads	Iran (total)	Percentage of Nomads Share
Population	1,186,830	72,848,000	1.6
Sheep and lambs	13,585,689	50,000,000	27.2
Goat and kids	8,348,529	22,000,000	37.9
Cattle and calf	253,877	7,000,000	3.6

pastoral nomadic wisdom in favor of irresponsible governmental policies is detrimental to the sustainable use and preservation of the montane grass- and shrublands. Whatever the strategies to overcome governmental "tragedies of (ir-)responsibilities" (Kreutzmann 2012b; 2013b) will be, they can and will be successful only if nomads and agro-pastoralists, with their accumulated traditional knowledge are supported by increased scientific observations. This may be called the pragmatic aspect of research on climate change and mountain pastoralism.

However, we claim that our study also shows the academic and scientific value of in-depth analyses of both natural and social science research in harsh and not well-documented environments. The fact that meteorological data show a high degree of convergence with the results of empirical field research and the knowledge of local people is a strong argument for intensified trans- and interdisciplinary research endeavors in regard to global environmental change issues. Our study demonstrates the validity and the value of such endeavors. Going one step further: Serious empirical field research in remote areas and with environmentally sensitive and knowledgeable people may very well produce results and insights that are comparable to the outcomes of so-called "objective" data. This holds true especially for research on local to regional scales where those objective facts and figures may not be available.

References

Allan, N. J. R.; Knapp, G. W. and Stadel, C. (eds.) (1988): Human impact on mountains. New Jersey.

Ansari-Renani, H. R.; Rischkowsky, B.; Mueller, J. P.; Seyed Momen, S. M. and Moradi, S. (2013): Nomadic pastoralism in Southern Iran. In: Pastoralism: Research, Policy and Practice 3, 11. (http://www.pastoralismjournal.com/content/3/1/11). DOI: 10.1186/2041-7136-3-11

Beck, L. (1991): Nomad. A year in the life of a Qashqai tribesman in Iran London.

Birkmann, J. (ed.) (2006): Measuring vulnerability to natural hazards: towards disaster resilient societies. Tokyo, New York, Paris.

Black-Michaud, J. (1986): Sheep and land. The economics of power in a tribal society. Cambridge.

Bohle, H. G. (2001): Vulnerability and criticality. Newsletter of the International Human Dimensions Programme on Global Environmental Change 2/2001, 1–5.

– (2007): Living with vulnerability: livelihoods and human security in risky environment. Intersections Publications Series of UNU-EHS 6. Bonn.

Borsdorf, A.; Grabherr, G.; Heinrich, K.; Scott, B. and Stötter, J. (eds.) (2010): Challenges for mountain regions – tackling complexity. In: Raumforschung und Raumordnung 69 (2), 129–131. DOI: 10.1007/s13147-010-0072-0

Brklacich, M. and Bohle, H. G. (2006): Assessing human vulnerability to global climatic change. In: Ehlers, E. and Krafft, T. (eds.): Earth system science in the anthropocene. Berlin, 51–61.

Brooks, N. (2003): Vulnerability, risk and adaptation: a conceptual framework. Tyndall Centre Working Paper 38, 1–16. Norwich.

Cruz, R. V.; Harasawa, H.; Lal, M.; Wu, S.; Anokhin, Y.; Punsalmaa, B.; Honda, Y.; Jafari, M.; Li, C. and Huu Ninh, N. (2007): Asia. Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In: Canziani, O. F.; Parry, M. L.; Palutikof, J. P.; van der Linden, P. J. and Hanson, C. E. (eds.): Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, 469–506.

Ehlers, E. and Schetter, C. (2001): Pastoral nomadism and environment: Bakhtiari in the Iranian Zagros Mountains. In: Petermanns Geographische Mitteilungen 145 (2), 44–55.

Ford, J. D. and Smit, B. (2004): A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change. In: Arctic 57 (4), 389–400.

Garthwaite, G. (1983): Khans and Shahs. A documentary analysis of the Bakhtiari in Iran. Cambridge.

Hagedorn, H.; Haars, W.; Busche, D. and Förster, H. (1975): Zur Geomorphologie des Shir-Kuh-Massivs (Zentral-Iran) In: Z. Geomorph. NF, Suppl. 23, 146–156.

Hayes, M. (2002): Drought indices. National Drought Mitigation Center, University of Nebraska. http://www.civil.utah.edu/~cv5450/swsi/indices.htm

Hirsch, R. M. and Slack, J. R. (1984): A nonparametric trend test for seasonal data with serial dependence. In: Water Resources Research 20 (6), 727–32. DOI: 10.1029/WR020i006p00727

Huber, R.; Rigling, A.; Bebi, P.; Brand, F. S.; Briner, S.; Buttler, A.; Elkin, C.; Gillet, F.; Grêt-Regamey, A.; Hirschi, C.; Lischke, H.; Scholz, R. W.; Seidl, R.; Spiegelberger, T.; Walz, A.; Zimmermann, W. and Bugmann, H. (2013): Sustainable land use in mountain regions under global change: synthesis across scales and disciplines. In: Ecology and Society 18 (3), 36. DOI: 10.5751/ES-05499-180336

IPCC (2012): Managing the risks of extreme events and disasters to advance climate change adaptation. Special Report of the Intergovernmental Panel on Climate Change. Cambridge.

IRICS (INTERNATIONAL RESEARCH INSTITUTE FOR CLIMATE AND SOCIETY) (2011): Data homogenity. http://iridl.ldeo.columbia.edu/dochelp/StatTutorial/Homogeneity/

ISC (IRANIAN STATISTICS CENTER) (2012): National census of pastoral nomads in 2008. http://www.amar.org.ir/ashayerkoochande/default-1570.aspx

Johnson, D. L. (1969): The nature of nomadism: a comparative study of pastoral migrations in southwestern Asia and northern Africa. Research Paper 118. Dept. of Geography, University of Chicago. Chicago.

Kreutzmann, H. (ed.) (2012a): Pastoral practices in High Asia. Dordrecht.

– (2012b): Pastoralism - a way forward or back? In: Kreutzmann, H. (ed.): Pastoral practices in High Asia. Dordrecht, 323–335.

– (2013a): Recent results from pastoralism research and development practice. In: Études mongoles et sibériennes, centrasiatiques et tibétaines 43–44. DOI: 10.4000/emscat.2017

– (2013b): The tragedy of responsibility in High Asia: modernizing traditional practices and preserving modernist worldviews. In: Pastoralism: Research, Policy and Practice 3, 7. (http://www3.pastoralismjournal.com/content/3/1/7). DOI: 10.1186/2041-7136-3-7

Kreutzman, H. and Schütte, S. (2011): Contested commons – multiple insecurities of pastoralists in North-Eastern Afghanistan. In: Erdkunde 65 (2), 99–119. DOI: 10.3112/erdkunde.2011.02.01

Kuhle, M. (1976): Beiträge zur Quartärmorphologie SE-Iranischer Hochgebirge. Die quartäre Vergletscherung des Kuh-i-Jupar. Göttinger Geogr. Abh. 67, 1. Göttingen.

Messerli, B. and Ives, J. (eds.) (1984): Mountain ecosystems, stability and instability. Berne.

Modarres, R. and Vicente, de P. R. (2007): Rainfall trends in arid and semi-arid regions of Iran. In: Journal of Arid Environments 70 (2), 344–355. DOI: 10.1016/j.jaridenv.2006.12.024

Mollinga, P. P (2010): Boundary work and the complexity of natural resources management. In: Crop Science 50 (Suppl. 1), 1–9. DOI: 10.2135/cropsci2009.10.0570

Montero, R. G.; Mathieu, J. and Singh, C. (2009): Mountain pastoralism 1500–2000. In: Nomadic Peoples 13(2), 1–16. DOI: 10.3167/np.2009.130201

Oberling, P. (1974): The Qashqai nomads of Fars. The Hague, Paris.

Preu, C. (1984): Die quartäre Vergletscherung der inneren Zardeh-Kuh-Gruppe (Zardeh-Kuh-Massiv), Zagros/Iran. Augsburg.

Price, M. F.; Byers, A.; Friend, D. A.; Kohler, T. and Price, L. W. (eds.) (2013): Mountain geography. Physical and human dimensions. Boulder.

Rathjens, C.; Troll, C. and Uhlig, H: (eds.) (1973): Vergleichende Kulturgeographie der Hochgebirge des südlichen Asien. Comparative cultural geography of the high-mountain regions of southern Asia. Wiesbaden.

Raziei, T. (2008): Investigation of annual precipitation trends in homogeneous precipitation sub-divisions of Western Iran. Balwois Conference. Ohrid, Republic of Macedonia.

Rodrigo, F. S.; Esteban-Parra, M. J.; Pozo-Vázquez, D. and Castro-Díez, Y. (1999): A 500-year precipitation record in Southern Spain. In: International Journal of Climatology 19 (11), 1233–1253. DOI: 10.1002/(SICI)1097-0088(199909)19:11<1233::AID-JOC413>3.0.CO;2-L

Scholz, F. (1991): Von der Notwendigkeit, gerade heute über Nomaden und Nomadismus nachzudenken. In: Scholz, F. (ed.): Nomaden – mobile Tierhaltung. Zur gegenwärtigen Lage von Nomaden und zu den Problemen und Chancen mobiler Tierhaltung. Berlin, 7–37.

– (1995): Nomadismus: Theorie und Wandel einer sozioökologischen Kulturweise. Stuttgart.

– (1999): Nomadismus ist tot. In: Geographische Rundschau 51, 248–255.

– (2008): Nomadism: a socioecological mode of culture. Theory, phenotypes, change, decline. Ulaanbaatar.

Schütte, S. (2012): Pastoralism, power and politics: access to pastures in Northern Afghanistan. In Kreutzmann, H. (ed.): Pastoral practices in High Asia. Dordrecht, 53–69.

– (2013): Livelihoods in scarcity - combined rainfed farming systems in Ishkamesh, Afghanistan. In: Erdkunde 67 (3), 223–239. DOI:10.3112/erdkunde.2013.03.02

Schweizer, G. (1970): Nordost-Azerbaidschan und Shah Sevan-Nomaden. In: Ehlers, E.; Scholz, F. and Schweizer, G. (eds.): Strukturwandlungen im Nomadisch-Bäuerlichen Lebensraum. Wiesbaden, 83–148.

– (1973): Lebens-und Wirtschaftsformen iranischer Bergnomaden im Strukturwandel. Das Beispiel der Shah Sevan. In: Rathjens, C.; Troll, C. and Uhlig, H. (eds.): Vergleichende Kulturgeographie der Hochgebirge des südlichen Asiens. Wiesbaden, 168–173.

Star, S. L. and Griesemer, J. (1989): Institutional ecology, 'translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology. In: Social Studies of Science 19, 387–420. DOI: 10.1177/030631289019003001

Storch, H. v. (1999): Misuses of statistical analysis in climate research. In: Storch, H. v. and Navarra, A. (eds.): Analysis of climate variability: applications of statistical techniques: proceedings of an autumn school organized by the Commission of the European Community on Elba from October 30 to November 6, 1993. Stuttgart.

Tahmasebi, A. (2013), Pastoral vulnerability to socio-political and climate stresses. The Shahsevan of North Iran. ZEF Development Studies 22. Berlin, 169.

Tapper, R. (1979): Pasture and politics: economics, conflict, and ritual among Shahsevan nomads of northwestern Iran. London.

– (1997): Frontier nomads of Iran: a political and social history of the Shahsevan. Cambridge.

– (2002): Introduction: the nomads of Iran. In: Tapper, R. and Thompson, J. (eds.): The nomadic peoples of Iran. London, 10–39.

Tecer, L. H. and Cerit, O. (2009): Temperature trends and changes in Rize, Turkey, for the period 1975 to 2007. In: Clean Soil, Air, Water, 37 (2), 150–159. DOI: 10.1002/clen.200800021

Troll, C. (ed.) (1972): Geoecology of the high-mountain regions of Eurasia: prodeedings of the Symposium of the International Geographical Union, Commission on High-Altitude Geoecology, Nov. 20–22, 1969 at Mainz. Wiesbaden.

Turner, B. L.; Kasperson, R.; Matson, P. A.; McCarthy, J. J.; Corell, R. W.; Christensen, L.; Eckley, N.; Kasperson, J. X.; Luers, A.; Martello, M. L.; Polsky, C.; Pulsipher, A. and Schiller, A. (2003): A framework for vulnerability analysis in sustainability science. In: PNAS 100 (14), 8074-8079. DOI: 10.1073/pnas1231335100

UNISDR (UNITED NATIONS INTERNATIONAL STRATEGY FOR DISASTER REDUCTION) (2009): Terminology on disaster risk reduction. Geneva.

Authors

Dr. Asghar Tahmasebi
Assistant Professor,
Department of Rural Planning
Faculty of Geography, Kharazmi University
No.49 South Mofatteh,
Postal Code:14911 15719

and

National Science and Technology Correspondent to
UNCCD Secretariat for National Committee to Combat Desertification
Forest Range and Watershed Management Org.
Shemiran,Minicity
Postal Code:1955756113
Tehran,
Iran
asghar@uni-bonn.de

Prof. em.Dr. Eckart Ehlers
Center for Development Research
University of Bonn
Walter-Flex-Strasse 3
53113 Bonn
Germany
ehlers@giub.uni-bonn.de

Prof. Dr. Conrad Schetter
Scientific Director
Bonn International Center for Conversion (BICC)
Pfarrer Byns-Strasse 1
53121 Bonn
Germany
schetter@bicc.de